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DEPARTMENT OF THE ARMY

PROGRAM EXECUTIVE OFFICE
ARMORED SYSTEMS MODERNIZATION
WARREN, MICHIGAN 48397-5000



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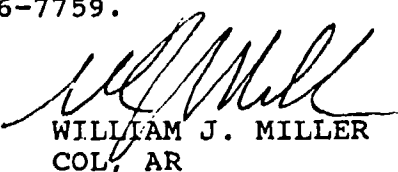
2 Jun 92

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Groundwars Analysis of the Laser Warning Receiver
(LWR) - Phase II.

1. PM Survivability Systems and the Tank Automotive Command (TACOM) have formed the Combat Vehicle Survivability Assessment Cell (CVSAC), a computer modeling cell to perform in-house analyses of survivability technologies.
2. Enclosed is the report of Phase II of the Laser Warning Receiver Groundwars analysis. This is the second of four phases of an ongoing study. In Phase I, the CVSAC showed the benefits of an LWR capable of locating a threat laser source to the degree needed to cue a main gun engagement. Phase II examined an LWR linked with the tactics of popping smoke, seeking cover in attack, and moving to an alternate fire position in defense.
3. For further information, please contact Mr. Dennis Bjoraker or Ms. Lisa Jokubaitis, DSN 786-7759.

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WILLIAM J. MILLER
COL, AR
Project Manager
Survivability Systems

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SUBJECT: Groundwars Analyses of the Laser Warning Receiver
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U.S. Army Armor School, ATTN: ATSB-CD/ATSB-TSMT/ATZK-TF, Fort Knox, KY 40121-5212

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AMC Smart Munitions Program Office, ATTN: AMSMI-RD-SM, Redstone Arsenal, AL 35898-5246

U.S. Army Survivability Management Office, ATTN: SLCSM-SE, 2800 Powder Mill Road, Adelphi, MD 20783-1145

U.S. Army Missile Command, ATTN: AMSMI-OR-SA, Redstone Arsenal, AL 35898-5060

U.S. Army Communication-Electronics Center for EW/RSTA, ATTN: AMSEL-RD-EW-S, Ft. Monmouth, NJ 07703

U.S. Army Tank-Automotive Command, ATTN: AMSTA-RS/AMSTA-ZEA, Warren, MI 48397-5000

U.S. Army Laboratory Command, ATTN: AMSLC-TD, 2800 Powder Mill Road, Adelphi, MD 20783-1145

Defense Technical Information Center, ATTN: DTIC-FDAC, Cameron Station, Bldg 5, Alexandria, VA 22304-6145

U.S. Army Materiel Command, 5001 Eisenhower Avenue, ATTN: AMCAE Alexandria, VA 22333-0001

DIRECTOR:

U.S. Army Armament Research Development & Engineering Center, ATTN: SMCAR-FSS-E/SMCAR-FSF-B/SMCAR-CCH, Picatinny Arsenal, NJ 07806-5000

U.S. Army Vulnerability Assessment Office, ATTN: SLCVA, White Sands Missile Range, NM 88002-5512

Ballistic Research Laboratory, ATTN: SLCBR-SE/SLCBR-VL-D/SLCBR-IB-P/SLCBR-LF-F/SLCBR-TB, Aberdeen Proving Ground, MD 21005

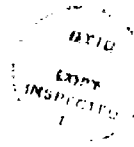
U.S. Army Materiel Systems Analysis Activity, ATTN: AMXSY-GC, Aberdeen Proving Ground, MD 21005-5071

U.S. Army TRADOC Analysis Command, ATTN: ATRC-WA, White Sands

SFAE-ASM-SS

SUBJECT: Groundwars Analysis of the Laser Warning Receiver
(LWR) - Phase II.

Missile Range, NM 88002-5502
Defense Advanced Research Planning Agency, ATTN: TTO, 1400 Wilson
Blvd, Arlington, VA 22209-2308
Precision Guided Weapons Countermeasures Test and Evaluation
Directorate, ATTN: OTD, White Sands Missile Range, NM 80002-
5519
U.S. Army Combined Arms Command and Fort Leavenworth, ATTN: ATZL-
CDE-C, Fort Leavenworth, KS 66027-5000



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Dennis Bjoraker Program
Executive Office, Armored Systems
Modernization ATTN: AFAE-ASM-SS-P
Warren, MI 48397-5000 NWW 6/19/92

LASER WARNING RECEIVER (LWR)
EFFECTIVENESS ANALYSIS (PHASE II)
EXECUTIVE SUMMARY

1. BACKGROUND. The Combat Vehicle Survivability Assessment Cell (CVSAC) is conducting an on-going study to identify the potential survivability impact of installing an LWR on an armored vehicle. The CVSAC used Groundwars, a force-on-force stochastic computer model developed and maintained by AMSAA. In Phase I, the CVSAC showed the benefits in a one-on-one scenario of an LWR capable of locating a threat laser source to the degree needed to cue a main gun engagement. In this phase, Phase II, the CVSAC analyzed the benefits of an LWR linked with the tactics of popping smoke (in attack and defense), seeking cover (in attack), and moving to an alternate fire position (in defense) upon activation of the LWR. AMSAA has reviewed and concurred with CVSAC's methodology and analysis results.

2. ASSUMPTIONS/SET-UP. This analysis considered an m-on-n scenario in which Red and Blue tanks attacked and defended. During the attack, the tanks (Red or Blue) were fully exposed; during the defense, the tanks were in hull-defilade. There were 2000 repetitions of each scenario made for this analysis. The effectiveness of the Blue tank when equipped with an LWR was compared to a basecase in which Blue had no LWR, did not pop smoke, did not seek cover, and did not move to an alternate fire position.

3. RESULTS. Laser Warning Receivers provide early warning of impending threat engagements. An LWR capable of warning the tank commander to pop smoke or take evasive maneuvers benefits the Blue tank during both the attack and the defense. The LWR's had a greater impact on Blue tank survivability in the defense than in the attack. The LWR linked with popping smoke showed more benefit than when linked with seeking cover or moving to an alternate fire position. This analysis suggests that an LWR's ability to warn of an impending engagement and take measures to break line-of-sight will provide a significant improvement to a tank's survivability.

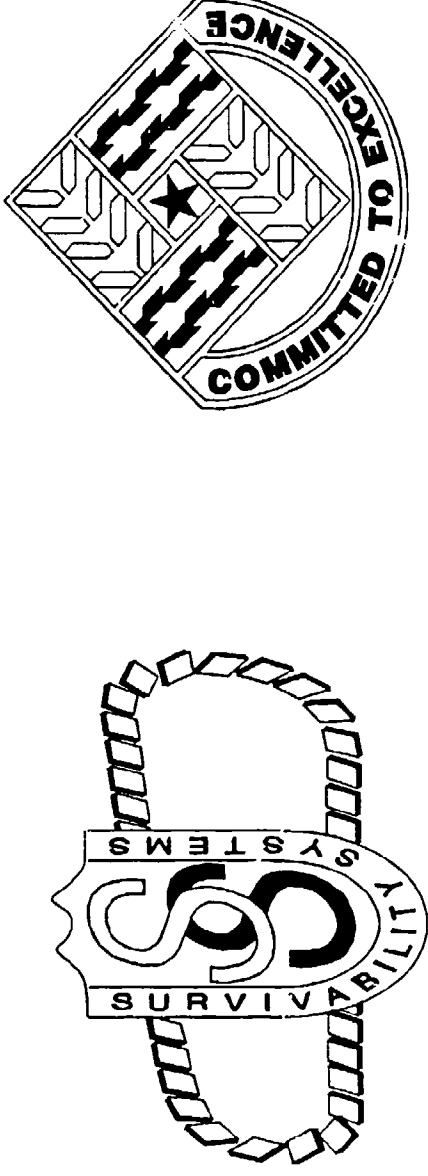
4. THE WAY AHEAD. Follow-on analyses will:

a. In an m-on-n scenario, examine the effectiveness of an LWR capable of locating a threat laser source to the degree needed to cue a main gun engagement. The analysis will examine the tactics of returning fire, popping smoke, seeking cover, and moving to an alternate fire position.

b. Examine the sensitivity of the LWR's benefits as a function of direction of arrival accuracy.

Laser Warning Receiver Effectiveness Analysis (II)

29 MAY 1992



Combat Vehicle Survivability Assessment Cell

PEO ASM / USATACOM

Warren, Michigan

PURPOSE

Analyze the effectiveness of a Laser Warning

Receiver (LWR) linked with the tactics:

- in attack: popping smoke or seeking cover
- in defense: popping smoke or moving to an alternate fire position

Analysis Tool

Groundwars 4.2 Combat Model

- Stochastic combat model in which both sides have homogeneous forces totalling 20 or less
- All attackers begin the simulation separated by the same distance from each defender
- Statistically simulated terrain
- Round type (KE, ATGM, Fire & Forget), firing cycle times, accuracy, and probability of kill are all explicitly modelled
- Game ends at a pre-determined range, or when a side is all dead or all out of ammo

METHODOLOGY

- Hunfeld terrain
- CV-CPOA Attack Distribution
- LWR is always on
- Blue has LWR except for baseline case in which Blue does not pop smoke, seek cover, or move to an alternate fire position
- LWR probability of detecting a lase = 90 %
- The following measures are used to break Line-of-Sight upon activation of the LWR:
 - Heavy and medium concentration visual smoke
 - Heavy and medium concentration IR smoke
 - Seeking cover (in attack)
 - Moving to an alternate fire position (in defense)
- Each tank can pop smoke 2 times

METHODOLOGY

(CONT.)

- With an LWR, if a tank has depleted its supply of smoke, it will seek cover (attack) or move to an alternate fire position (defense)
- Each time a tank pops smoke, the smoke provides 120 degree coverage of the tank after 5 seconds and then lasts for a duration of 45 seconds
- Engagement begun at 4000 meters; ends at 100 meters if neither side is out of ammo or all dead
- Loss Exchange Ratio (LER) = Red Dead / Blue Dead
Fractional Exchange Ratio (FER) =
Original Force Ratio (Blue/Red) X Loss Exchange Ratio
- Break-even point = The point where the battle is a draw
(FER = 1 ; LER = 3 in defense and 1/3 in attack)
- AMSAA concurred with methodology, study results, and code changes to Groundwars

RESULTS

BLUE DEFENSE

BATTLE SCENARIO

BLUE

4 Future Armored Fighting
Vehicles with Modern Fire
Control Systems

Kinetic Energy (KE)
round - overmatches
Red armor

2nd generation FLIR

3 km and 7 km
visibilities played

RED

12 Future Armored Fighting
Vehicles with Modern Fire
Control Systems

Kinetic Energy (KE)
round - does not overmatch
Blue armor

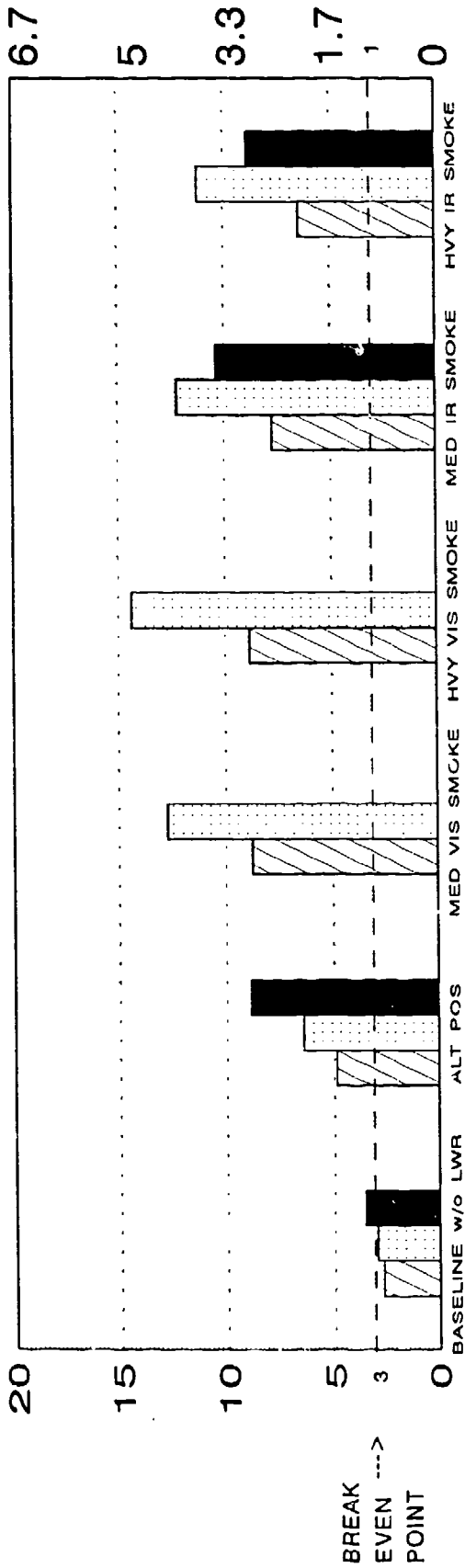
DVO or 1st generation FLIR

3 km (DVO and FLIR) and
7 km (DVO only) visibilities
played

BLUE W/ LWR, MOVING TO ALTERNATE POSITION, AND SMOKE

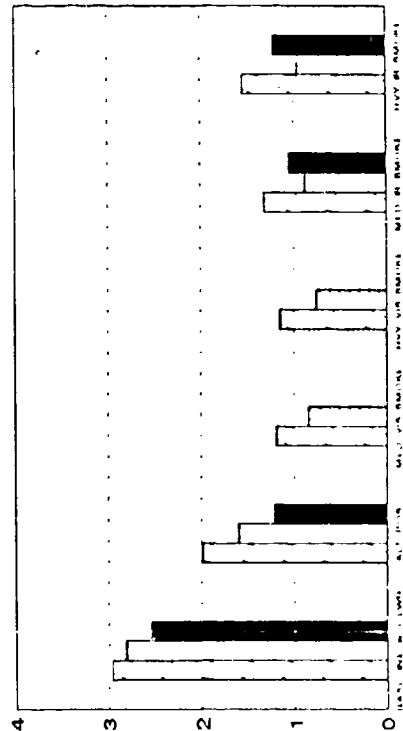
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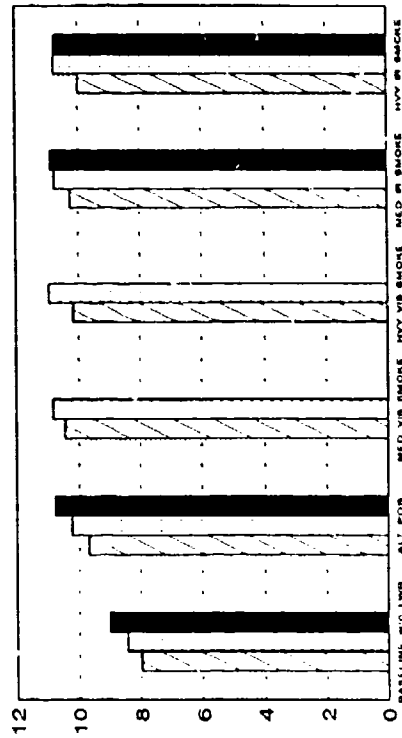


7 km - Red DVO 3 km - Red DVO 3 km - Red FLIR

AVERAGE # BLUE DEAD



AVERAGE # RED DEAD



BLUE ATTACK

BATTLE SCENARIO

BLUE

12 Future Armored Fighting
Vehicles with Modern Fire
Control Systems

Kinetic Energy (KE)
round - overmatches
Red armor

2nd generation FLIR

3 km and 7 km
visibilities played

RED

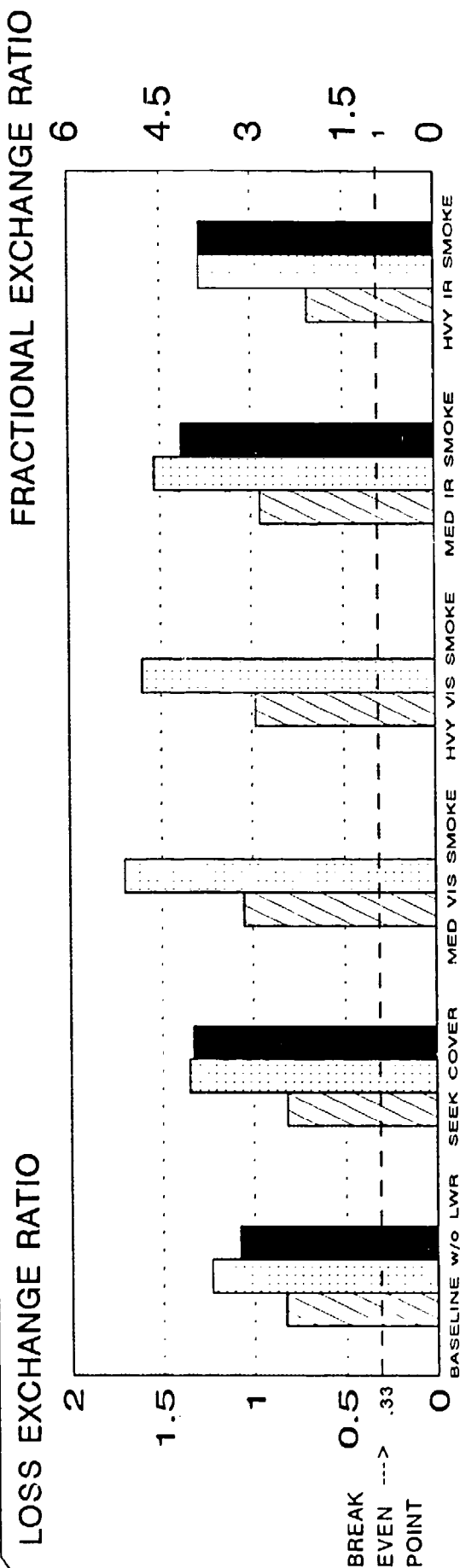
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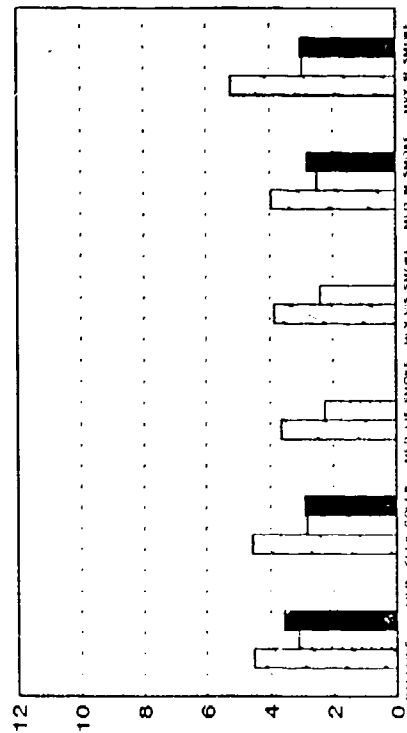
DVO or 1st generation FLIR

3 km (DVO and FLIR) and
7 km (DVO only) visibilities
played

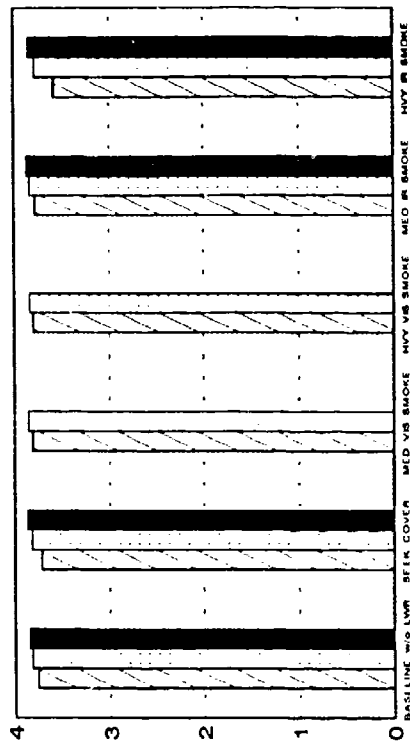
BLUE W/ LWR, SEEKING COVER AND SMOKE



AVERAGE # BLUE DEAD



AVERAGE # RED DEAD



CONCLUSIONS

- The LWR linked with smoke was the most effective option:
 - Outperformed the baseline, seeking cover, and moving to an alternate position in virtually all scenarios
 - Medium concentration outperformed heavy concentration smoke by blinding Red's inferior sensors while allowing Blue partial visibility
 - Worked better in the Defense than in the Attack
 - Worked better against the Red DVO than against the Red FLIR
- The LWR linked with moving to an alternate position in the Defense showed significant benefit in all scenarios, especially against the Red FLIR
- The LWR linked with seeking cover in the Attack showed a noticeable improvement only against the Red FLIR
- The LWR linked with smoke, seeking cover, and moving to an alternate position performed better with a 3km visibility range rather than a 7km visibility range

THE WAY AHEAD

LWR

Accuracy?

Countermeasures?

Tactics?

Trade-offs?

PHASE I

Benefits of
high accuracy
with return fire

PHASE II

Benefits of LWR linked with smoke,
moving to an alternate position,
and seeking cover

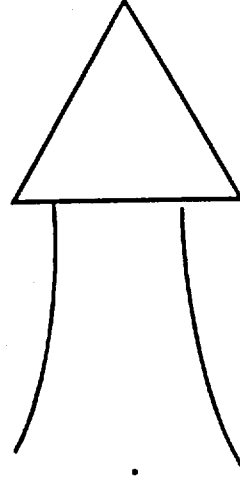
PHASE III

Benefits of combining
high accuracy LWR/ return
fire with smoke, moving to an
alternate position, and
seeking cover

PHASE IV

Effectiveness of
high accuracy vs.
low accuracy

Performance
Specifications
Desired



APPENDIX

NOTE: EXCURSIONS RUN FOR BOTH BLUE ATTACK AND BLUE DEFENSE
 DEFINITION OF MANEUVER: IN ATTACK - TO SEEK COVER
 IN DEFENSE - TO MOVE TO AN ALTERNATE FIRE POSITION

BLUE										RED									
MED	IR	SMOKE		VISUAL	HIGH	MANEUVER	LWR	SMOKE		MANEUVER	LWR	SENSOR	DAY CLARITY						
		IR	HIGH					IR	MED				3km	7km					
BASELINES																			
--	--	--	--	--	--	--	--	--	--	--	--	DVO	3km						
--	--	--	--	--	--	--	--	--	--	--	--	DVO	7km						
--	--	--	--	--	--	--	--	--	--	--	--	FLIR	3km						
BLUE WITH LWR AND MANEUVERING																			
--	--	--	--	--	--	YES	YES	--	--	--	--	DVO	3km						
--	--	--	--	--	--	YES	YES	--	--	--	--	DVO	7km						
YES	--	--	--	--	--	YES	YES	--	--	--	--	DVO	3km						
YES	--	--	--	--	--	YES	YES	--	--	--	--	FLIR	3km						
--	--	--	--	YES	--	YES	YES	--	--	--	--	DVO	3km						
--	--	--	YES	YES	--	YES	YES	--	--	--	--	DVO	7km						
--	YES	--	--	--	--	YES	YES	--	--	--	--	DVO	3km						
--	YES	--	--	--	--	YES	YES	--	--	--	--	DVO	7km						
--	YES	--	--	--	--	YES	YES	--	--	--	--	FLIR	3km						
BLUE WITH LWR AND SMOKE																			
--	--	--	YES	--	--	YES	YES	--	--	--	--	DVO	3km						
--	--	--	YES	--	--	YES	YES	--	--	--	--	DVO	7km						
YES	--	--	--	--	--	YES	YES	--	--	--	--	DVO	3km						
YES	--	--	--	--	--	YES	YES	--	--	--	--	FLIR	3km						
--	--	--	--	--	--	YES	YES	--	--	--	--	DVO	3km						
--	--	--	--	YES	--	YES	YES	--	--	--	--	DVO	7km						
--	YES	--	--	YES	--	YES	YES	--	--	--	--	DVO	3km						
--	YES	--	--	--	--	YES	YES	--	--	--	--	DVO	7km						
--	YES	--	--	--	--	YES	YES	--	--	--	--	FLIR	3km						
BLUE WITH LWR AND SMOKE, RED WITH LWR AND MANEUVERING																			
--	--	--	YES	--	--	YES	YES	--	YES	YES	YES	DVO	3km						
--	--	--	YES	--	--	YES	YES	--	YES	YES	YES	DVO	7km						
YES	--	--	--	--	--	YES	YES	--	YES	YES	YES	DVO	3km						
YES	--	--	--	--	--	YES	YES	--	YES	YES	YES	DVO	7km						
YES	--	--	--	--	--	YES	YES	--	YES	YES	YES	FLIR	3km						
--	--	--	--	YES	--	YES	YES	--	YES	YES	YES	DVO	3km						
--	--	--	--	YES	--	YES	YES	--	YES	YES	YES	DVO	7km						
--	YES	--	--	--	--	YES	YES	--	YES	YES	YES	DVO	3km						
--	YES	--	--	--	--	YES	YES	--	YES	YES	YES	DVO	7km						
--	YES	--	--	--	--	YES	YES	--	YES	YES	YES	FLIR	3km						
BLUE WITH LWR AND MANEUVERING, RED WITH LWR AND MED IR SMOKE																			
--	--	--	--	YES	--	YES	YES	YES	--	--	--	DVO	3km						
--	--	--	--	YES	--	YES	YES	YES	--	--	--	DVO	7km						
--	--	--	--	YES	--	YES	YES	YES	--	--	--	FLIR	3km						

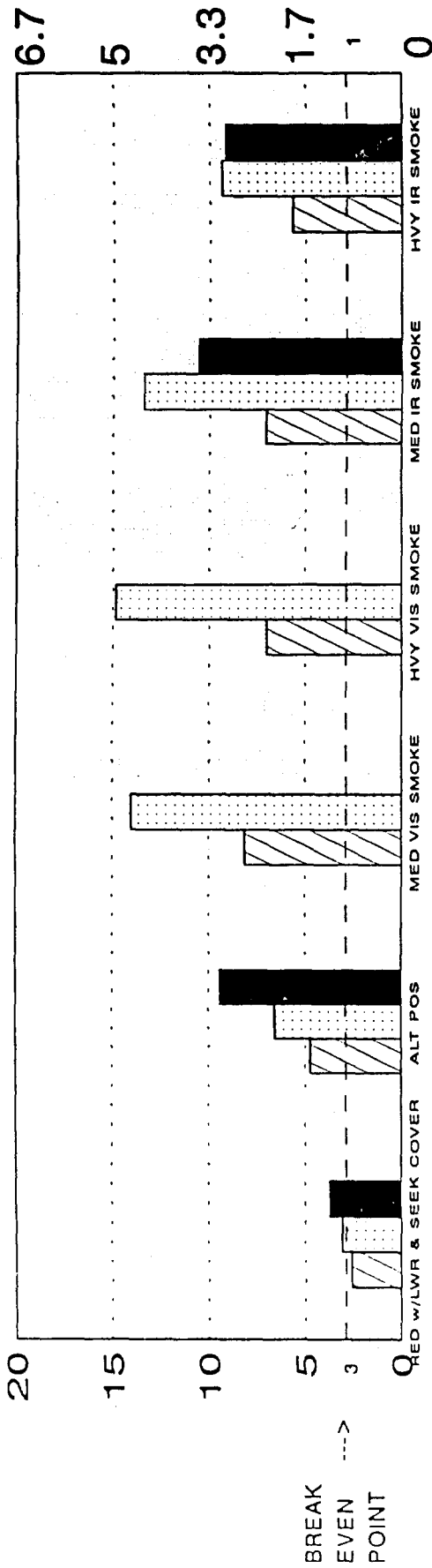
BLUE DEFENSE

RED W/ LWR AND SEEKING COVER

BLUE W/ LWR , MOVING TO ALTERNATE POSITION, AND SMOKE

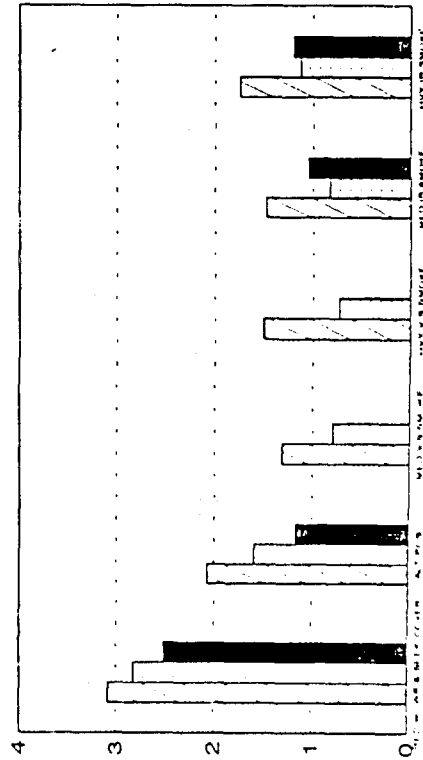
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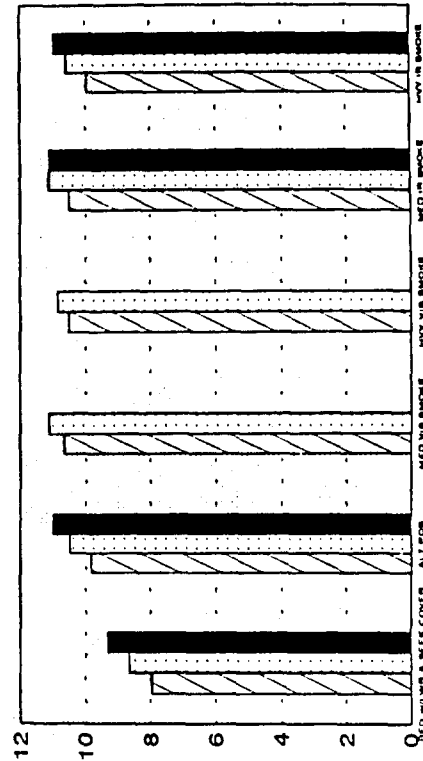


7 km - Red DVO 3 km - Red DVO 3 km - Red FLIR

AVERAGE # BLUE DEAD



AVERAGE # RED DEAD

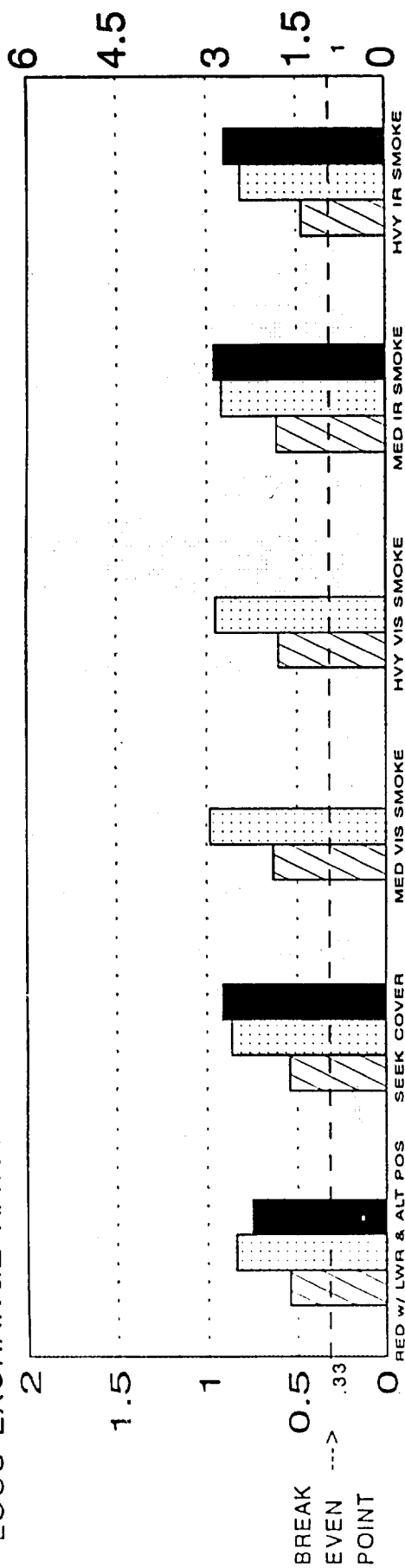


BLUE ATTACK

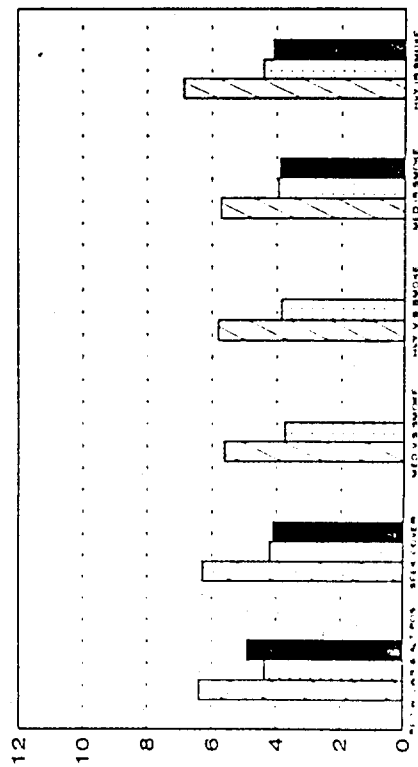
RED W/ LWR AND MOVING TO ALTERNATE POSITION
BLUE W/ LWR, SEEKING COVER, AND SMOKE

LOSS EXCHANGE RATIO

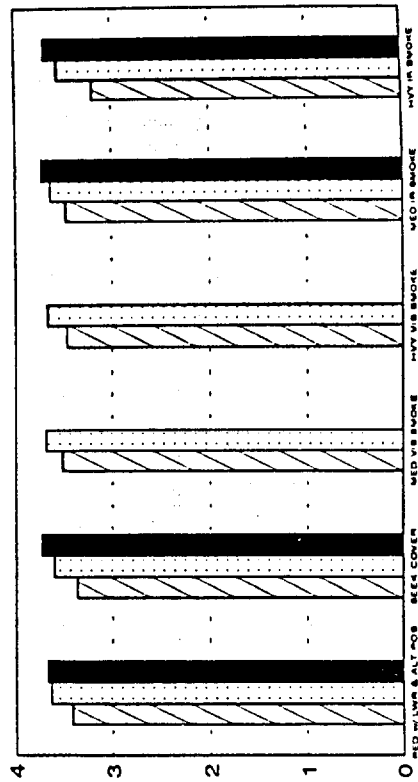
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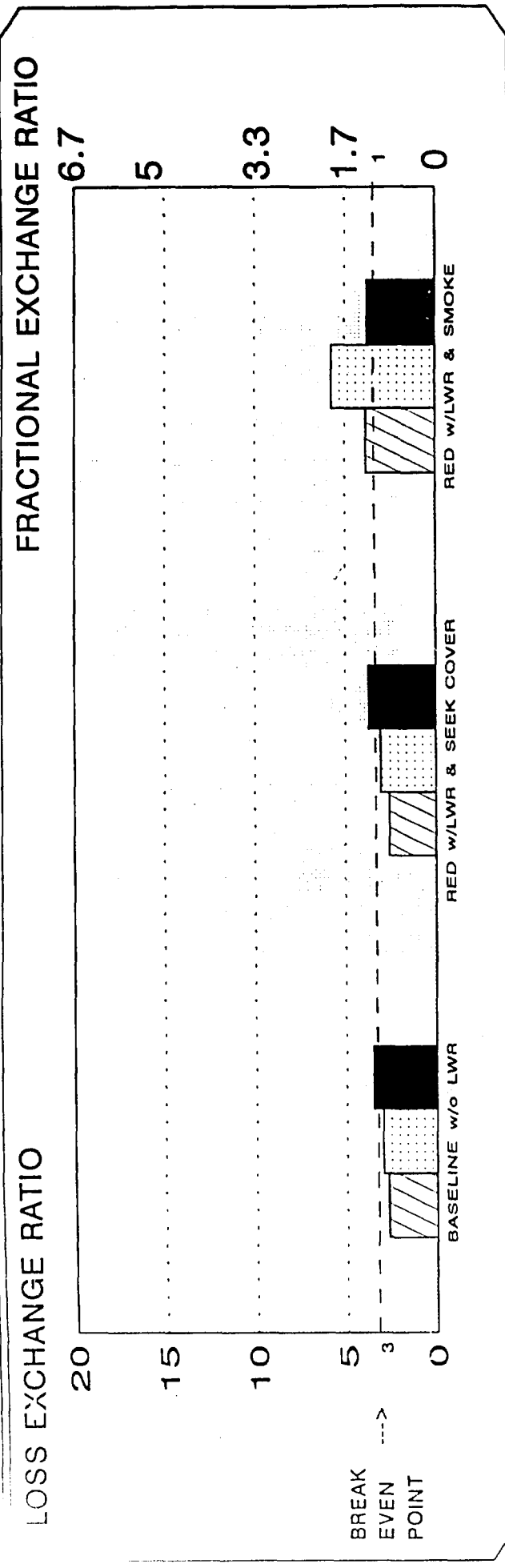


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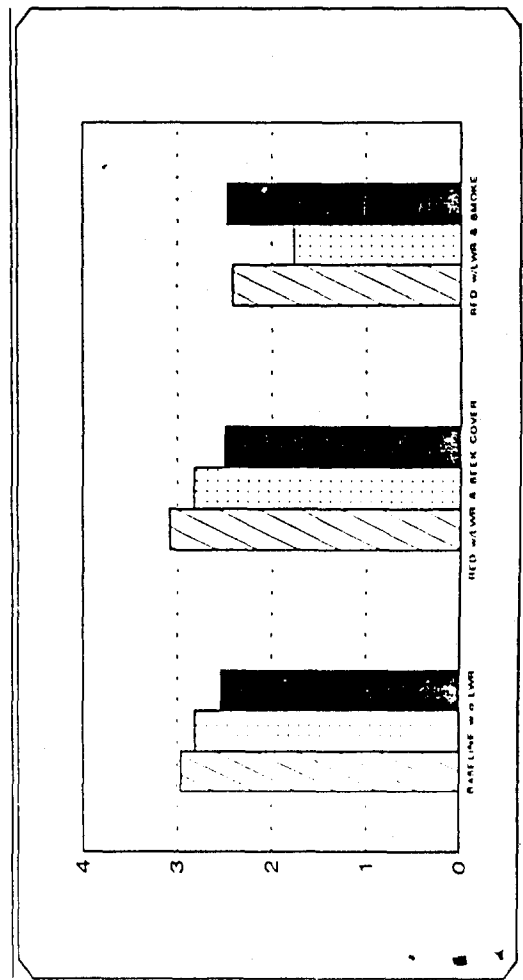
BLUE DEFENSE

BASELINE COMPARISONS

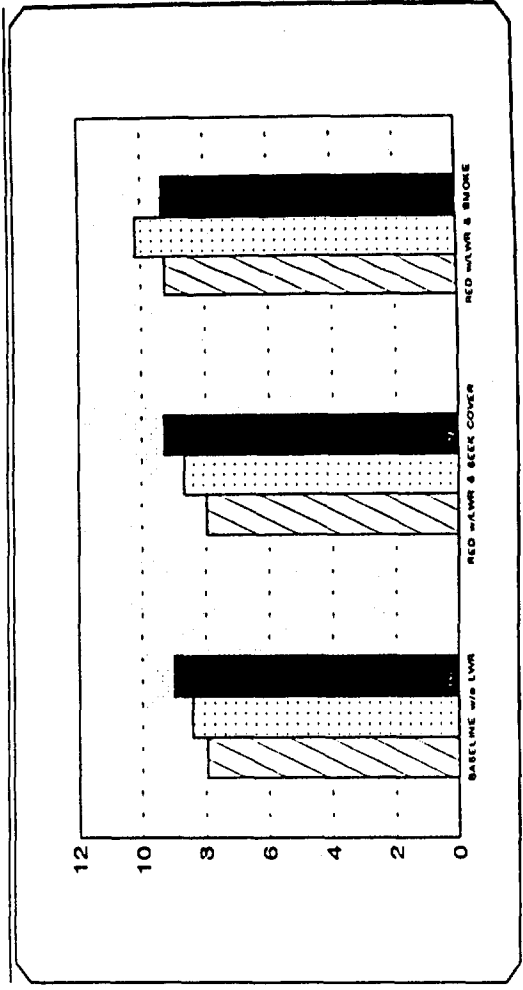


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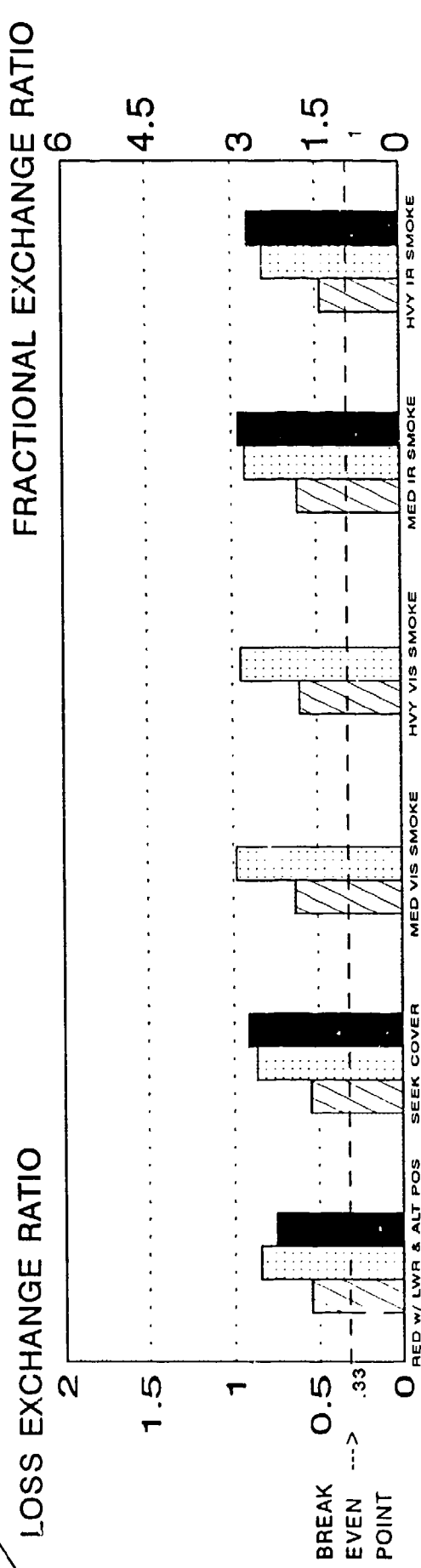
AVERAGE # BLUE DEAD



AVERAGE # RED DEAD

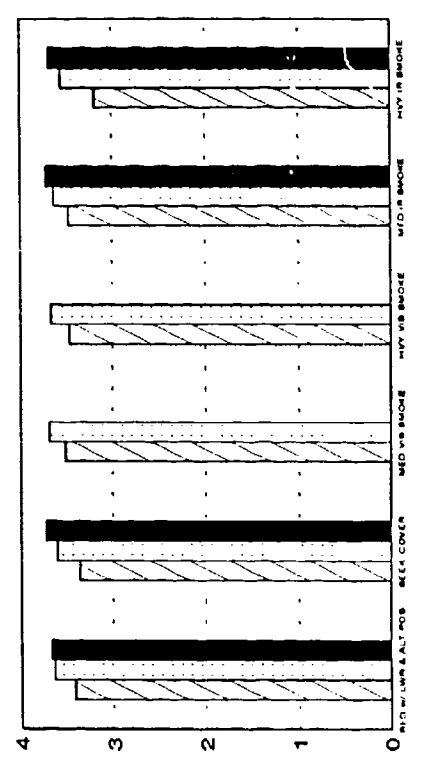
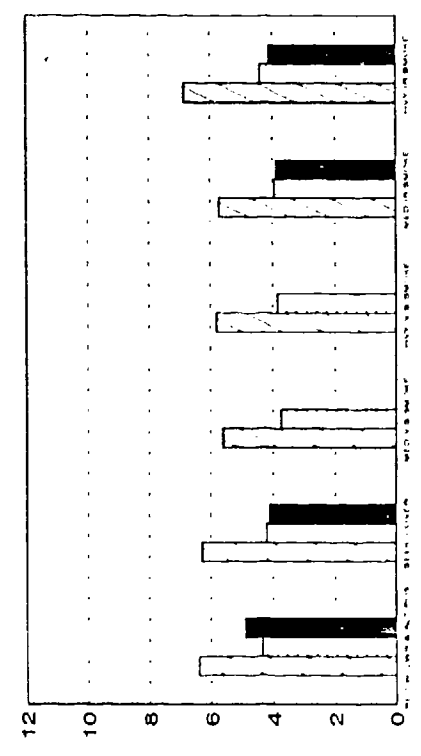


RED W/ LWR AND MOVING TO ALTERNATE POSITION BLUE W/ LWR, SEEKING COVER, AND SMOKE



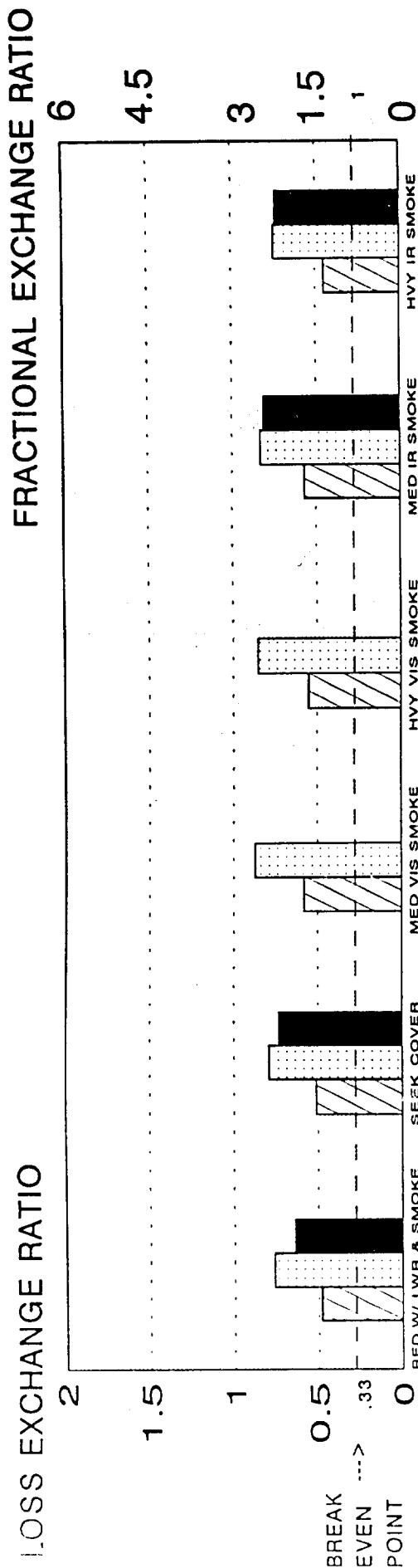
7 km - Red DVO 3 km - Red DVO 3 km - Red FLIR

AVERAGE # BLUE DEAD AVERAGE # RED DEAD

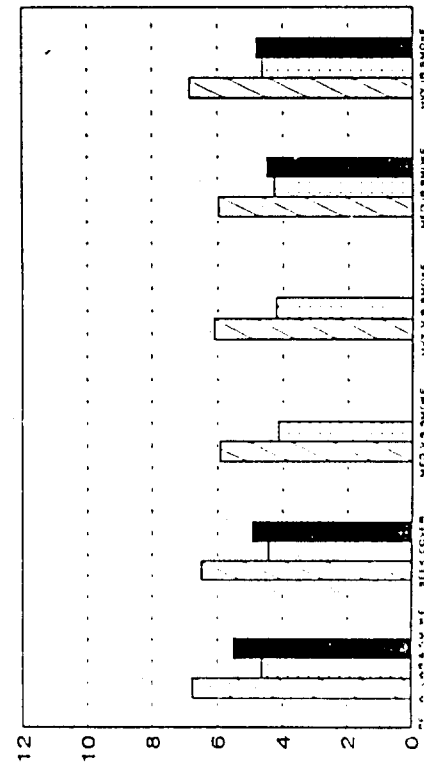


BLUE ATTACK

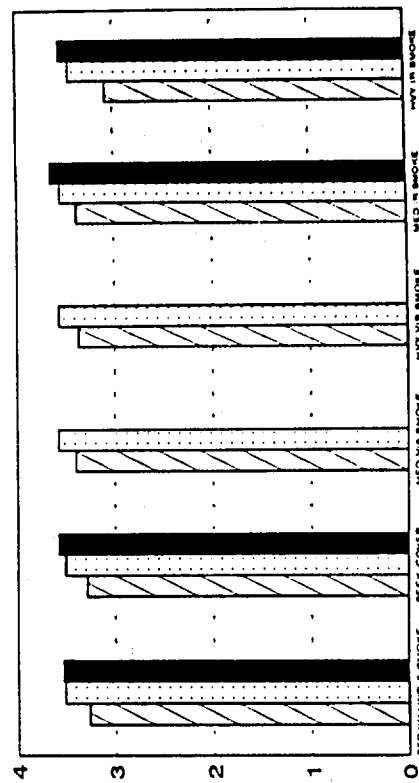
RED W/ LWR & MED IR SMOKE
BLUE W/ LWR, SEEKING COVER, AND SMOKE



AVERAGE # BLUE DEAD



AVERAGE # RED DEAD

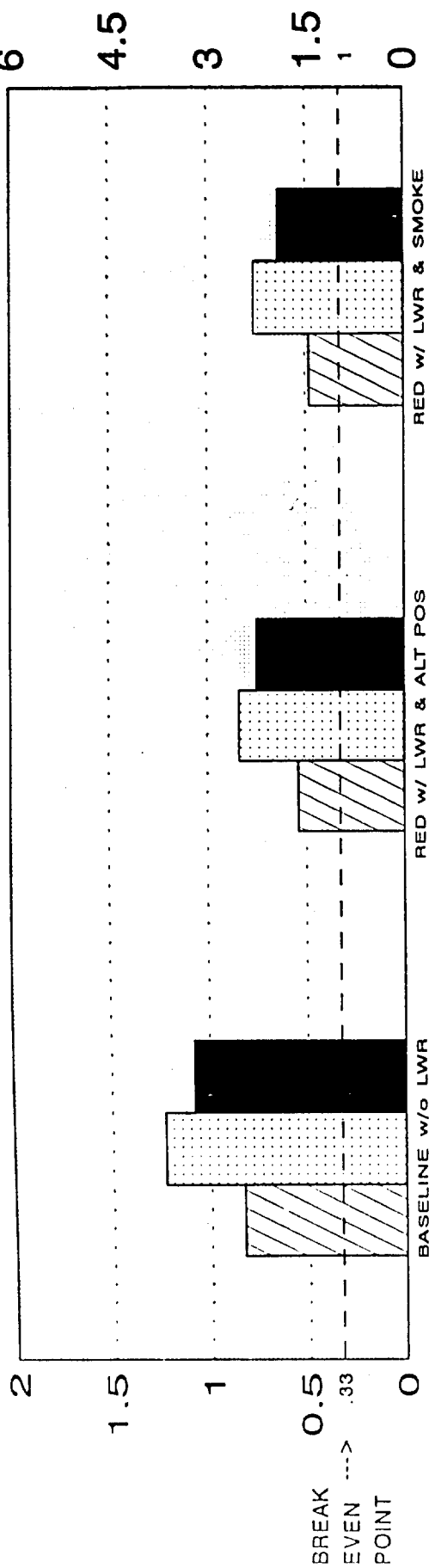


BLUE ATTACK

BASELINE COMPARISONS

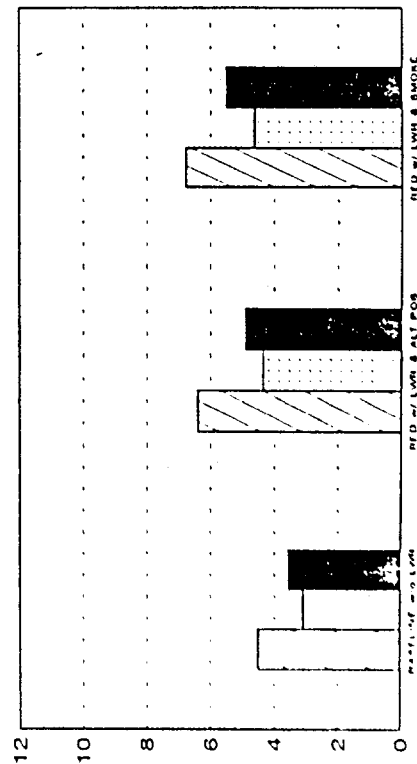
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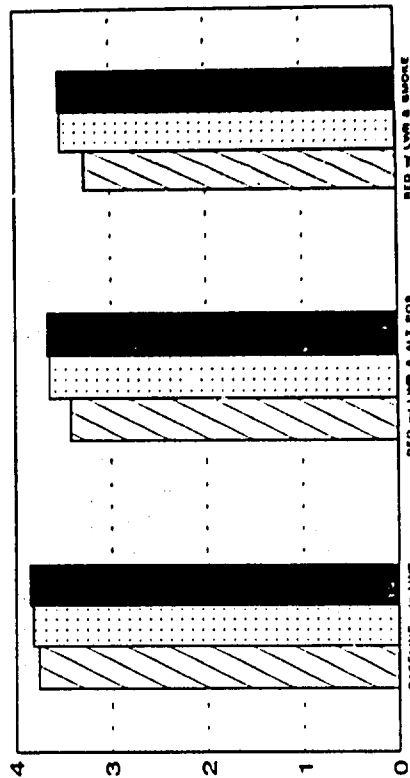


7 km - Red DVO 3 km - Red DVO 3 km - Red FLIR

AVERAGE # BLUE DEAD

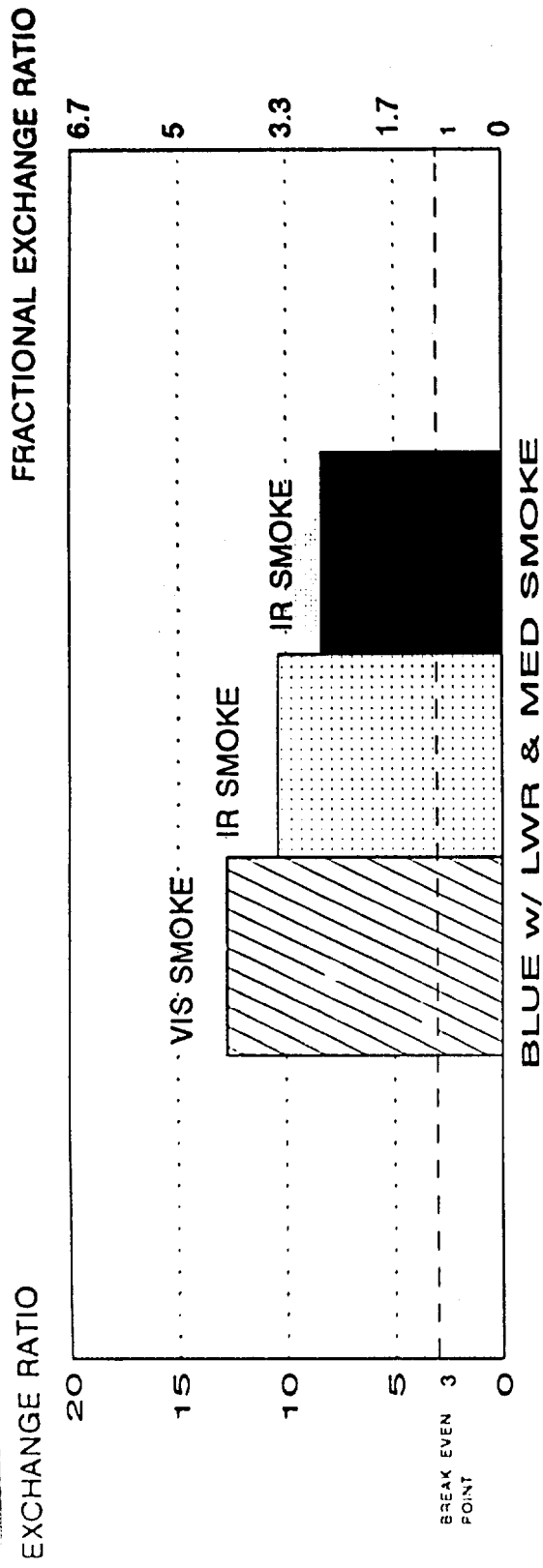


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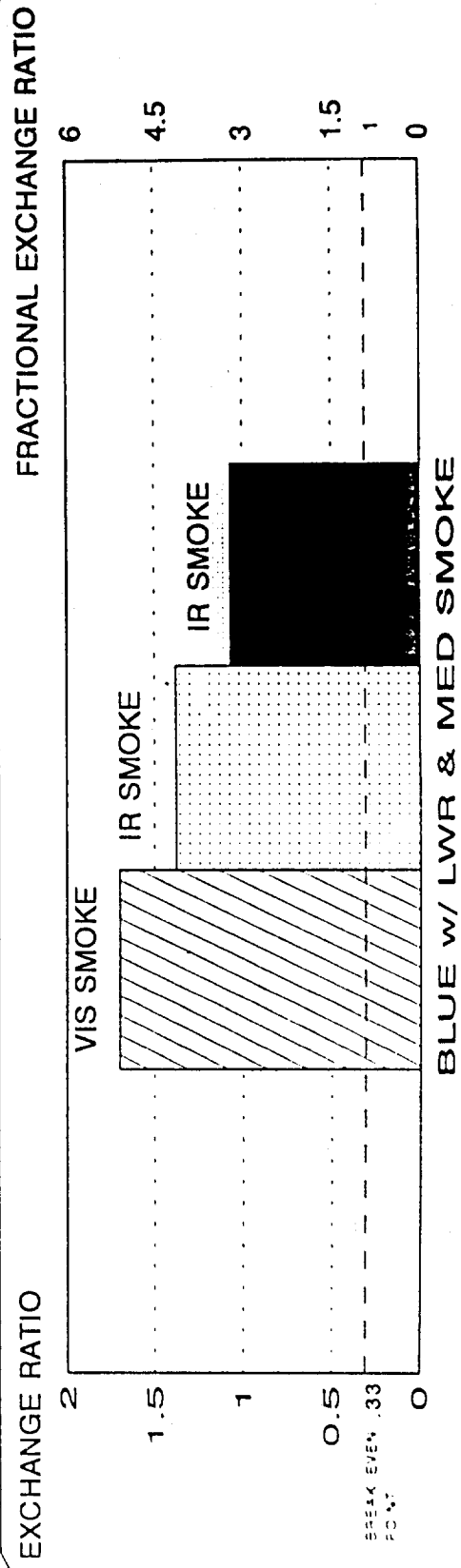


SENSITIVITY ON RED SENSOR

BLUE DEFENSE



BLUE ATTACK



3 km - RED DVO 3 km - RED FLIR I 3 km - RED FLIR II